Solving problems by searching

Chapter 3

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Announcements

- Please consult the new version of the assessment plan on eFundi

A.I.
ARTIFICIAL INTELLIGENCE

Top 10

1	Ambs
2	LordFarquaad
3	Jabiru
4	Kennis
5	Flippers
6	CrazyCow
7	Tweezer
8	Worsrol
9	Shocky
10	TheFlash180

http://blogs.thegospelcoalition.org/kevindeyoung/files/2015/01/top-10-films.jpg

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Lecture outline

- Problem-solving agents

Problem-solving agents

Romania

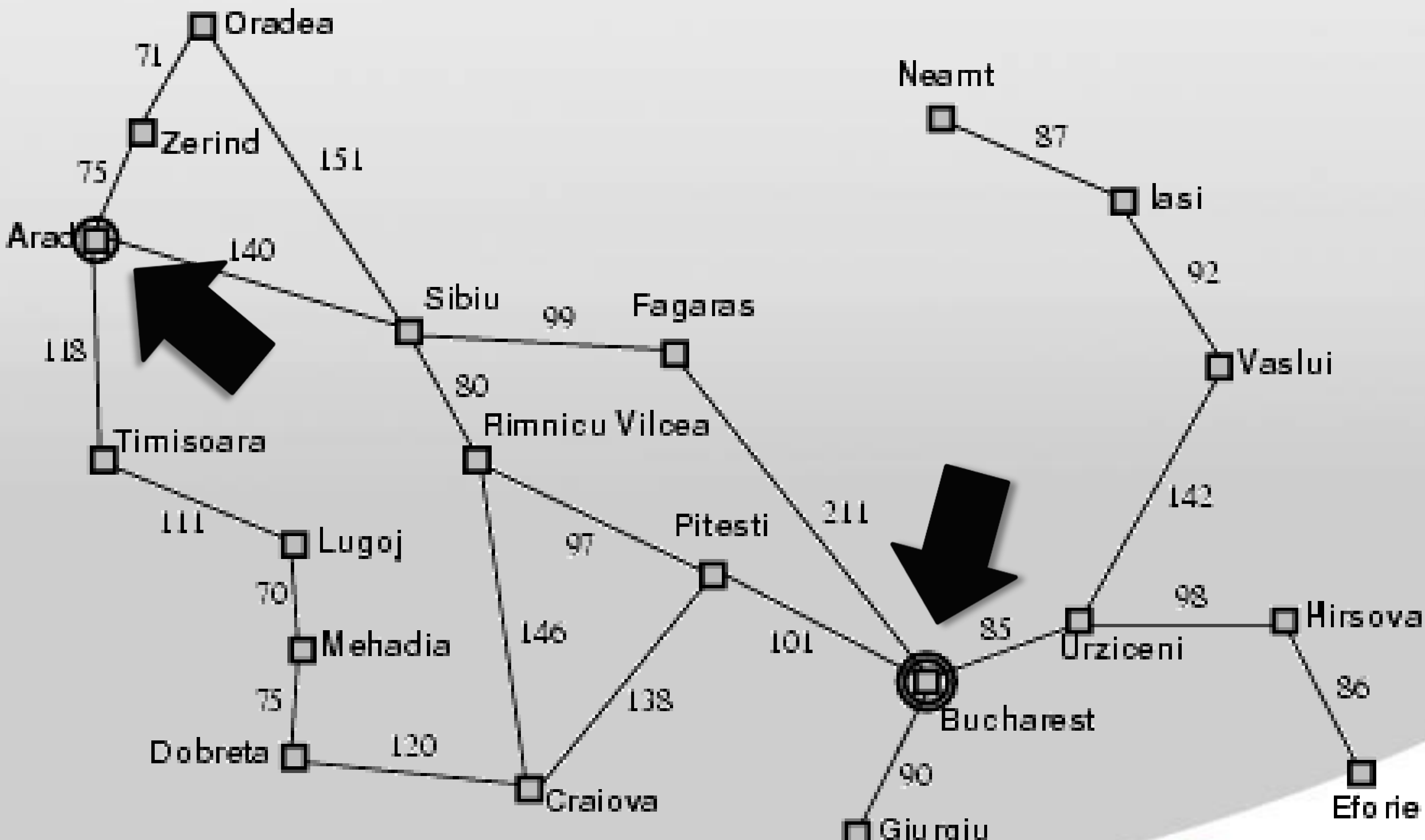
Problem-solving agents

Arad

Problem-solving agents

- Three roads from Arad
  - Sibiu, Timisoara or Zerind
- When the environment is unknown, the agent can execute one action at random
- We assume the agent has access to information about the world, such as the following map

Problem-solving agents



Problem-solving agents

- With this information, the agent can follow a four-phase problem solving approach:

1. Goal formulation – adopts a goal
2. Problem formulation – devise description of states and actions to reach goal
3. Search – simulates sequences of actions in model that reaches the goal
4. Execution – execute actions in the solution, one at a time

Problem-solving agents

- In a fully observable, deterministic, known environment, the solution to any problem is a fixed sequence of actions: e.g. drive to Sibiu, then Fagaras, then Bucharest
- If the model is correct, then once the agent has found a solution, it can ignore its percepts while it is executing the actions
- This an open-loop system: ignoring the percepts breaks the loop between agent and environment

Problem-solving agents

- If there is a chance that the model is incorrect, or the environment is nondeterministic, then the agent would be safer using a closed-loop approach that monitors the percepts
- In partially observable or nondeterministic environments, a solution would be a branching strategy that recommends different future actions depending on what percepts arrive

Problem-solving agents

- A search problem is being defined formally by six components:
    1. A set of possible **states** that the environment can be in (called the **state space**)
    2. The **initial state** that the agent starts in (e.g. Arad)
    3. A set of one or more **goal states**. Sometimes there is one goal state (e.g. Bucharest), sometimes there is a small set of alternative goal states

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Problem-solving agents

- A search problem is being defined formally by six components:
  3. Sometimes the goal is defined by a property that applies to many states (potentially an infinite number)
  4. The **actions** available to the agent. Given a state *s* ACTIONS(*s*) returns a finite set of actions that can be executed in *s*. We say that each of these actions is applicable in *s*
  5. A **transition model**, which describes what each action does. RESULT(*s*, *a*) returns the state that results from doing action *a* in state *s*

Problem-solving agents

- A search problem is being defined formally by six components:
  6. An **action cost function**, denoted by ACTION-COST(*s*, *a*, *s'*) when we are programming or $c(s, a, s')$ when we are doing math, that gives the numeric cost of applying action *a* in state *s* to reach state *s'*
- A sequence of actions forms a path
- A solution is a path from the initial state to a goal state

Problem-solving agents

- An optimal solution has the lowest path cost among all solutions
- We assume that action costs are additive; that is, the total cost of a path is the sum of the individual action costs
- An optimal solution has the lowest path cost among all solutions
- The state space can be represented as a graph in which the vertices are states and the directed edges between them are actions

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Problem-solving agents

- Our formulation of the problem of getting to Bucharest is a model — an abstract mathematical description — and not the real thing
- Compare the simple atomic state description Arad to an actual cross-country trip, where the state of the world includes so many things
- The process of removing detail from a representation is called abstraction

Problem-solving agents

- A good problem formulation has the right level of detail
- The abstract states and actions we have chosen correspond to large sets of detailed world states and detailed action sequences
- The abstraction is valid if we can elaborate any abstract solution into a solution in the more detailed world

Problem-solving agents

- The abstraction is useful if carrying out each of the actions in the solution is easier (without further search or planning) than the original problem
- The choice of a good abstraction thus involves removing as much detail as possible while retaining validity and ensuring that the abstract actions are easy to carry out

Assignment

- Study: Chapter 3.1 (Problem Solving Agents) of the AIMA e-book
- Theory Quiz 4: Chapter 3.1 (Problem Solving Agents) of the AIMA e-book
  - Thursday, 15 April 2021
- Test 1: Chapter 1 (Introduction) to Chapter 3.1 (Problem Solving Agents) of the AIMA e-book
  - Thursday, 22 April 2021